Identifying the Human Fingerprint in Observed Cloud Trends

Motivation

How much the planet warms due to increasing greenhouse gases is critically dependent on how clouds respond.

- Determine the fingerprint of anthropogenic climate change is detectible in the nearly 30-year ISCCP and PATMOS-x satellite cloud datasets
- Use climate models to determine when one should expect such responses (the "signal") to become distinguishable from the "noise" arising from unforced climate variability.

Approach

- Following the technique developed in Marvel & Bonfils (2013), we 1) define indicators of cloud amount C(t), latitude D(t), and height H(t) of five extrema in the zonally averaged total cloud fraction field; and 2) derive the multivariate "fingerprint" that characterizes their coherent response to external forcings.
- We estimate the time at which a signal of externally forced cloud change emerges from background noise in models and whether the anthropogenic signal is present in observations.

Impacts

The strength of the forced signal in the PATMOS-x dataset is *not* compatible with internal climate variability, but *is* compatible with GCM simulations including anthropogenic forcings.

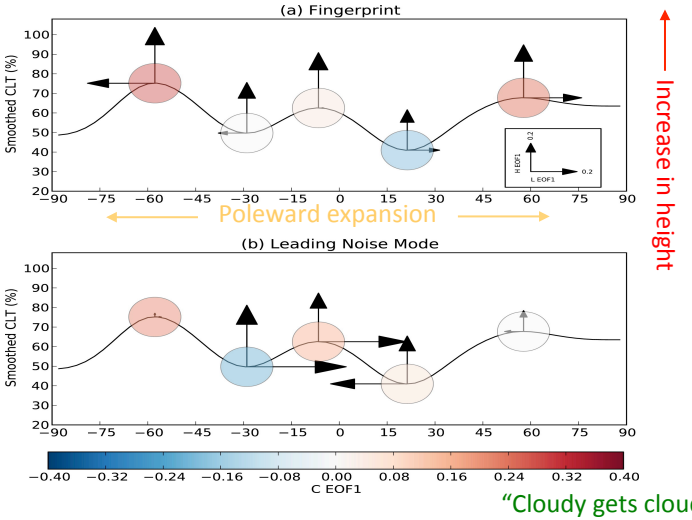

Fig. 1: a. Fingerprint: leading EOF of the cross-variance matrix of the multi-model average C(t), D(t) and H(t) from historical simulations forced by human activities. b. Primary noise mode (ENSO).

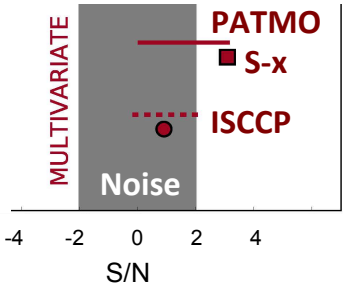

Fig. 2: Signal-to-noise ratio of the multivariate anthropogenic fingerprint. Values of S/N that lie outside the gray noise envelope are incompatible with internal variability (detection). If the observed S/N (circle for ISCCP and square for PATMOS-x) lies within the 95% distributions estimated from forced models (horiz. lines), it can reasonably be attributed to external forcing.

Marvel, K, MD Zelinka, SA Klein, C Bonfils, PM Caldwell, C Doutriaux, BD Santer, and KE Taylor, 2015: External influences on modeled and observed cloud trends, J. Climate, 28, 4820-4840 New status: accepted/published